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PRELIMINARY REPORT

LIVESTOCK AND RANGELAND IMPROVEMENT PROJECT • MOROCCO

by
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February 1972

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Preliminary Report

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INTRODUCTION

The Livestock and Rangeland Improvement Project was initiated in 1968 as a joint Government of Morocco (GOM) Livestock Service-USAID pilot effort to develop and demonstrate improved management and rehabilitation techniques for halting overgrazing and for increasing the production of forage and livestock products on Morocco's depleted rangelands. These rangelands support an estimated ninety percent of the nation's livestock. Most of them are raised under traditional conditions largely on unfenced "communal" (government controlled) and "private" rangelands approximating 12.4 million hectares (30 million acres) in extent.

Centuries of overgrazing and other abusive grazing practices have driven forage production on most of the rangelands far below their economic potential in both quantity and quality of forage produced. In turn the quantity and quality of livestock products produced on the rangelands are much below the potential of the breeding stock due to the severe overstocking and poor management practices.

The project has focused on improved management and technological research on communal grazing lands primarily in three important sheep producing regions. Each region represents a major ecological zone quite different from the others. These regions are: 1) Plaine d'Arid near Midelt; 2) Plaine de Tafрата near Guercif, and 3) Ait Rbaa Plaine near Kasba Tadla. In addition row plots of several range forage species were established in 1970 in the Chemaia area near Chichaoua to study their adaptation.

Research activities have been centered on 1) increasing forage production through seeding, chemical control of undesirable plants and natural rehabilitation through deferment; 2) increasing livestock production through improved nutrition, management, health and breeding, 3) conducting studies of range use and livestock production under traditional conditions and 4) controlling the use of the range resources through the application of existing legislation.

SUMMARY OF RESULTS

Preliminary tests began in 1968 in three regions, Midelt, Kasba Tadla and Guercif revealed several species and varieties of introduced and local grasses which appear to be well adapted. Field scale trials suggest that some of these varieties may be suitable for large scale seeding of selected areas of Morocco's depleted rangelands. At Midelt preliminary data from grazing trials Intermediate wheat grass (*Agropyron Intermedium*) planted in February 1970 indicate that forage production by this species may exceed by 5-6 times that of native sage range, and 50 to 100 times that of alfa grass. At Kasba Tadla, Harding grass (*Phalaris tuberosa*, var. *Stremtera*) seeded in December 1970 has made excellent growth. At Guercif although the performance of certain species is encouraging, the potential for forage production is limited by the low and uncertain level of rainfall.

Land preparation and seeding techniques have been studied and suitable methods for carrying out these operations identified. The cost of seeding will depend on the species used, the condition of the site and the operations performed. However, it appears that seeding costs on a field scale basis will range from 100 to 200 DH per hectare. Under good management the productive life of such a seeding should be 15-30 years.

A study to demonstrate the effect of improved forage, health and management conditions on sheep was carried out on the Plaine d'Arid at Midelt during the period April to October 1971. A principal objective of the study was to determine the difference in live weight gains of animals grazing on seeded wheat grass, and on the traditional unimproved native sage range. The study showed that the gain in live weight of lambs grazing on the wheat grass was five times (45.7 kgs vs 9.1 kgs) greater than the lambs grazing the native sage.

Detailed records showing kind and number of animals and period of grazing have been established for the livestock operators who use the Plaine d'Arid and Tafrata grazing perimeters at Midelt and Guercif respectively. These records show whether the operator is resident in the area or transient, the number of animals in his flock and the period of the year his flock grazes in the perimeter. A substantial number of the flocks are grazed under "Association" arrangements whereby a person with grazing rights agrees to graze for a fee animals belonging to a person who has no rights.

Controlling the use of communal grazing lands to prevent overstocking and consequent overgrazing is a primordial requirement for rangeland improvement. Use of the rangelands must be brought to balance with forage production. Experience and extensive contacts with livestock owners in the three areas during the past two years indicates that livestock owners are interested in better and more

productive rangelands. Grazing demonstrations like those carried out at Midelt are very useful to show and convince the traditional livestock owner that there are economic and practical ways of increasing animal production through improvement of grazing lands.

I. INCREASING FORAGE PRODUCTION

A. Range Seeding

Field tests to determine adaptability and production have been initiated on nearly 200 varieties of local and imported forage species. The experimental plantings vary in size from hand planted plots containing five to ten meter long rows of a number of varieties, to drill planted variety trials of less than one hectare each, to field size plantings of 50 hectares or more of selected species planted separately or in mixtures.

Rates of seeding and techniques of seedbed preparation were varied during the 1970-71 plantings at Plaine d'Arid for some of the key species to study their effects on stand establishment. For example, the seeding rates used for intermediate wheat grass (*Agropyron intermedium* var. Nebraska 50 and Oahe) varied from 4 kg to 15 kg per hectare. Land preparation and seeding techniques tested during the 1970-71 season varied from the most complete operation consisting of plowing, discing, rolling and drilling of seed to the simplest plowing with animal drawn plows and broadcasting the seed. Other seeding methods used include grubbing out undesirable native vegetation by hand and drilling the seed into the unworked ground. Drilling seed directly into a sage (*Artemisia alba*) site without plowing or otherwise reducing the natural competition, was tried in 1968. This latter method was completely unsuccessful due to the competition from existing vegetation.

A small amount of sprigging of vegetative transplants of species difficult to establish from seed has also been included but this method is not considered practical for the sites concerned in the Project. Experiments on chemical control of jujubier were initiated in May 1971 in the Plaine de Tafрата with encouraging results. Fertilizer trials of Nitrogen (as urea) and superphosphate (45% P₂O₅) applied at various rates on established wheat grass stands were initiated on the Plaine d'Arid site in 1971. Sub-soiling trials were also established during January 1971 at Midelt to test the effect of breaking up the caliche layer on forage production on seeded and native range. Vegetative response during the first year was not significant for either the fertilizer or sub-soiling treatments. Although the fertilizer trials should be continued, preliminary observations of the reseedings planted to date on the Plaine d'Arid indicate that the use of fertilizer is not necessary nor economic in the seeding of virgin sage land.

Seeding trials scheduled for the 1971-72 season had to be cancelled except for limited trials on the Tafrata because of the lack of funds to purchase seed and to perform the seeding operations. By pulling the drill behind a Landrover it was possible on the Tafrata to seed eight species directly into stubble of cereal rye that had been planted the previous season under the forage (hay production) study.

Table 1 - Total Hectares Seeded Under the Project Exclusive of Cereals

<u>Region</u>	<u>Approx. Est. Avg.</u>		<u>1968-69</u>	<u>1969-70</u>	<u>1970-71</u>	<u>1971-72</u>	<u>Total</u>
	<u>m</u>	<u>mm</u>					
Plaine d'Arid	1700	250-320	50	44	154	--	248
Plaine de Tafrata	600	200-250	row plots	30	54	29	113
Ait Rbaa Plaine	400	300-350	50	51	11	--	112
Chemalia	600	175-200	--	--	row plots	--	row plots
<u>Total Hectares</u>			100	125	219	29	473

B. Seeding Results

1. Plaine d'Arid - Midelt

The crested wheat grass seeding planted in 1968 yielded over 300 percent more forage during the April-October 1971 Grazing and Livestock Production trials than the adjacent sage range. In terms of meat production, 45.7 kgs per hectare were recorded for the lambs during the trials on the crested wheat grass seeding compared to 16.0 kgs on the sage range under the same management conditions.

Preliminary grazing trials on the intermediate wheat grass reseeding planted in February 1970 indicate that forage production for this species may exceed six times that of the native sage range.

Forage production increases ranging from 50 to 100 times may be attainable on the Alfa grass (*Stipa tenacissima*) areas in the

Upper Plaine d'Arid through seeding with intermediate wheat grass. Alfa grass was burned on a 21 hectare site in September 1970 followed by plowing and seeding in November to several forage species resulting in what appears to be an excellent kill of the alfa plants as well as successful establishment of intermediate and tall wheat grass. Alfa is a large, coarse, bunch grass of low palatability and nutritive value covering approximately thirty per cent of the Plaine d'Arid in almost pure stands. Carrying capacity estimates of the alfa areas are considered to be as low as one sheep unit per 50 to 100 hectares year long compared to approximately one sheep unit per three hectares on the sage range.

In addition to the Neb 50 and Oahe varieties of intermediate wheat grass, the following wheat grass species are also showing excellent potential for seeding of the upper Plaine d'Arid sage and alfa zones: Pubescent (*A. trichophorum*), Tall (*A. elongatum*) and Thickspike (*A. dasystachyum*). Although production on the 40 hectares of crested wheat grass (*A. cristatum*) seeded in 1968 has been excellent, further testing is required before this species can be recommended for large scale seeding, since subsequent plantings made in 1969 and 1970 resulted in poor stands. The reasons for the poor results from the subsequent seedings is believed to be due to the seed used which was from a source much farther north in the U.S. than that planted in 1968. The individual crested plants that have become established have made excellent growth indicating either poor seed or planting techniques. Crested seed from other sources as well as other varieties were planted in row plots in 1970; however, further testing on a field scale basis is required for this important forage species.

Local varieties of orchard grass (*Dactylis glomerata*) and Fescue (*Festuca arundinacea*) are also showing good potential for seeding.

Seeding trials on the lower Plaine d'Arid have been quite encouraging although the rainfall is less favorable - probably 25 to 75 cm less than on the upper area which is 100 to 300 meters higher. The 1970-71 plantings of pubescent, intermediate, crested and tall wheat grass appear well established. However, before operational scale seedings are attempted further trials and observations should be made because of the less favorable moisture conditions.

A number of species and varieties of legumes have been included in the trials at both locations but the results to date have not been conclusive. Although Sainfoin (*Onobrychis sativa* var. Eski) and alfalfa (*Medicago sativa* var. Travois) have shown some interesting results, further observations and trials are necessary before the seeding of grass - legume mixes can be recommended.

During the 1971 growing season precipitation was perhaps 30 per cent above normal making it a very good forage year. However, germination and emergence of the seedlings planted during the fall of 1970 were delayed until February-March 1971 due to lack of fall rains.

2. Ait Rbaa Plaine - Kasba Tadla

Harding grass (*Phalaris tuberosa* var. *Stemptora*) seeded at a rate of 12 kgs per hectare during December 1970 was outstanding both in seedling establishment and forage production during the first year. Fall rains in 1971 produced excellent early winter growth (30-50 cm by early February 1972) indicating that production during the second year 1972 will be very high. Several other species planted in 1970-71 are also indicating good adaptability. They are: Orchard grass (*Dactylis glomerata*), Tall wheat grass (*A. elongatum*), Fescue (*Festuca arundinacea*) and Smilo grass (*Oryzopsis miliacea*).

Among the legumes barrel medic (*Medicago truncatula*) and *Sanguisorba minor* are showing very good results in row trials. Travois, Ladak and Teton varieties of alfalfa (*Medicago sativa*) are also promising but require further testing. *Melilotus alba*, *Hedysarium coronarium*, and *Onobrychis sativa* were seeded in separate mixes with *Phalaris tuberosa* on a field basis. The results were rated very poor for the first year of observations.

The first seeding trials planted in the fall of 1968 were completely destroyed by a fire which swept the area in mid-1969. The Ait Rbaa area is an annual grass - jujubier (*Ziziphus lotus*) vegetative type that requires special care in seeding to avoid excessive competition from the annual grasses and broadleaf weeds.

Evaluation of the seeding trials is difficult because land preparation, except for some small plots plowed in February 1971, had to be done with a cover-crop disc harrow rather than a disc plow. In contrast to the dense annual grass and weed competition which occurred in 1971 on the tracts prepared in December 1970 with the cover-crop disc harrow, the tracts prepared with the heavy disc plow in February 1971 resulted in very little weed competition. Further trials are needed in land preparation techniques and time of plowing in order to avoid excessive annual competition. The trials to date, however, indicate that plowing and seeding in January or early February, after the annual grasses have attained around 8 cm growth, should minimize the competition from annuals.

Fertilizer trials should be included in future research programs as well as chemical control of jujubier.

3. Plaine de Tafрата - Guercif

The Plaine de Tafрата is considered marginal at best for seeding due to low rainfall although the results of the 1970-71 trials are encouraging. *Oryzopsis miliacea* and *Festuca arundinacea* in particular show promise on the upper site. Further trials could be established at higher altitudes where moisture conditions are somewhat more favorable. However, due to lower productive potential and cost-benefit ratio, Tafрата rates a much lower priority for seeding investments than the thousands of hectares of higher potential seedable rangelands elsewhere in Morocco needing seeding.

C. Seeding Costs

The seeding trials completed on the Plaine d'Arid indicate a total cost range between DH 100 to DH 200 per hectare for large scale seeding using heavy equipment and seed purchased in the U.S. The trials further indicate that seeding with Intermediate, variety Neb. 50 can be accomplished for approximately DH 100 on sites such as the sage areas on the Plaine d'Arid.

Seeding costs, of course, will vary directly with the cost of the seed, equipment and planting technique used. The seed cost will be somewhat more when the grass seed is sown in a mixture with a legume which is most desirable when conditions permit.

The Plaine d'Arid studies indicate the following range of costs:

Seed cost	33 to 50 DH per hectare
Land preparation and Planting	<u>67</u> to <u>150</u> DH per hectare
Total cost range	100 to 200 DH per hectare

The productive life of a range seeding is difficult to measure as there are many factors involved. However, the productive life span should approximate 15 to 30 years or more for seeding such as the Crested and Intermediate wheat grass plantings on the Plaine d'Arid, subject to proper use.

D. Cost of Seed

The variety, quantity, quality, time of purchase, shipping costs and rate of seeding are determining factors in seed costs.

The intermediate wheat grass (var. Nebraska 50) used during the 1969-70 and 1970-71 trials was purchased in August 1969 in the

United States at a cost of DH 8.45 per kg, CIF Casablanca. It is estimated that the cost of *Phalaris tuberosa* var. *Stenoptera* will approximate DH 12 per kg. By producing the seed locally, it should be possible to reduce seed costs materially. It is estimated that around 7,400 kgs of seed could have been harvested this year from the 37 hectare Plaine d'Arid Intermediate wheat grass seeding of 1970-71 if funds had been available. This would have been enough seed to plant over 900 hectares.

High priority should be given to the establishment of a "Plant Materials Center" for the testing selection, breeding and multiplication of range forage seed. Commercial seed production in the private sector should also be encouraged.

The seeding rate will vary with the forage species being planted, the seeding equipment and the conditions of the site. In the Plaine d'Arid seeding rate studies, the Intermediate seeding rates were varied from 4 to 15 kg per hectare representing an approximate spread in seed costs from DH 34 to DH 127 per hectare.

Based on the first year's observations, a seeding rate from six to eight kgs per hectare should be adequate for intermediate wheat grass seeding on the Plaine d'Arid. Compared to 15 kgs per hectare, seeding at 8 kg per hectare would represent a saving of 59 DH in seed costs per hectare or 59,000 DH per thousand hectares.

Although it was not possible to conduct seeding rate studies on other species, limited observations indicate that seeding *Phalaris tuberosa* at 6 to 10 kgs per hectare should be adequate on sites such as Ait Rbaa. Time did not permit the inclusion of spacing trials in the seeding rate studies, however, spacings of approximately 18 to 36 cm between rows are considered adequate.

E. Land Preparation and Planting

Seedbed preparation and seeding costs vary with the physical conditions of the site, the efficiency of the equipment used and the number of tillage operations involved. The studies conducted on the Plaine d'Arid during 1970-71 indicate that the full range of land preparation operations consisting of plowing, discing, and rolling are not necessary in seeding the sage zones. Plowing and seeding alone have given very good results and can be combined into one operation through either a multiple hitch arrangement or through mounting a seeder directly on the plow thereby minimizing costs. Success using this method requires that it be done at the proper time for seedling establishment. Where discing is not required, land preparation and sowing costs should approximate 23 to 34 DH per hectare depending on the extent operations can be combined and the type of equipment used.

In seeding the Alfa grass areas, plowing should be preceded by burning the Alfa plants. This can be readily accomplished during the summer months at a cost around 5 DH per hectare or less. Plowing during the dry summer and early fall months should be best for eradication of Alfa, followed by fall to early spring seeding either directly or after discing and rolling as conditions require. However, sage kill results were very good from plowing in January 1970 under moist soil conditions (normally inadvisable), and may be satisfactory for Alfa sites seeding as well during some years.

The time for seeding is the same for both the Alfa and sage areas. Studies conducted to date indicate that good results can be expected from seedings made during October through February and possibly March, however, fall seeding is preferred.

As previously mentioned, studies to date indicate that plowing and seeding after the annual grasses have germinated (fall-early winter) is preferred for the annual grass zones in the Ait Rbaa region. However, in order to extend the period of plowing, the sites to be seeded can be plowed during late spring to early summer and left fallow until conditions are favorable for seeding in the fall-early winter period. Discing and rolling, should precede the drilling operation under those circumstances where annual competition is present.

A "time study" was made by former USAID Contract Technician Walter Graves of the various seedbed preparation and seeding operations used on the Plaine d'Arid to determine costs based on actual operating time per hectare for the equipment available at the Bou Miq C.T. (Centre de Travaux). The results, which are summarized below, are based on 25 hectare tracts.

Table 2 - Actual Operating Time*

<u>Operation</u>	<u>Hrs. per Ha.</u>
Plowing (5 disc plow 1.5 - 1.7 m cut with crawler tractor)	2
Discing (offset cover-crop with crawler tractor)	1
Rolling (4.2 m, 3-element roller w/65 HP wheel tractor)	0.6
Seeding (4 IH grain drill w/65 HP wheel tractor)	0.6
Rolling & Drilling combined w/65 HP wheel tractor	0.6

* including allowance of 20% down time.

Table 3 - Cost of Operation Per Hectare*

Operation	Hrs. Per Hectare		Adjusted Costs - DH per Hectare					
	C.T. Charged Rate	Actual Operat'g Time	Insur- ance	Gas and Oil	Labor	Repair	Spare Parts	Total
Plowing	3.5	2.0	0.30	9.60	2.50	3.80	6.55	22.65
Discing	1.75	1.0	0.16	5.50	1.28	1.58	2.60	11.12
Rolling	1.0	0.6	0.15	2.70	1.05	0.78	1.32	5.92
Seeding	0.90	0.6	0.35	2.70	3.00	0.93	1.67	8.65
Rolling and Discing Combined	1.90	0.6	0.38	2.70	4.05	1.37	2.73	11.23

* Based on C.T. rates adjusted by actual time checks listed in Table 2.

The approximate cost per hectare for the various land preparation and sowing options used in the 1970/71 program based on the adjusted costs in Table 3 are listed below:

<u>Option I</u>		<u>Option II</u>	
<u>Operation</u>	<u>DH per Hectare</u>	<u>Operation</u>	<u>DH per Hectare</u>
Plowing	22.65	Plowing	22.65
Discing	11.12	Discing	11.12
Rolling	5.92	Rolling and	
Seeding	<u>8.65</u>	Seeding	
	48.34	Combined	<u>11.23</u>
			45.00

<u>Option III</u>		<u>Option IV</u>	
<u>Operation</u>	<u>DH per Hectare</u>	<u>Operation</u>	<u>DH per Hectare</u>
Plowing	22.65	Plowing	22.65
Rolling and		Seeding	<u>8.65</u>
Seeding			31.30
Combined	<u>11.23</u>		
	33.88		

Disc plows designed for rangeland plowing such as the Massey-Ferguson MF 63 or 67 Sundercut should be procured for large scale range plowing. These plows have maximum cutting widths varying from 2.95 to 4.27 meters. Each disc is individually mounted on spring loaded arms to minimize disc breakage from rocks. Multiple hook-ups of the plows can be arranged as well as the installation of accessory seed and fertilizer boxes to reduce land preparation and seeding costs to a minimum.

The "Time Study" shows that the Plaine d'Arid can be prepared for seeding by grubbing out the sage and Alfa with hand labor utilizing heavy hoes at a cost approximating 50 DH per hectare. After grubbing the sites were seeded with drills to wheat grass. Based on first year of observations, the results were not satisfactory in any respect due to the regeneration of sage and the poor stand of wheat grass resulting from the seeding.

Seedbed preparation with animal-drawn plows was also unsatisfactory. On a daily wage basis the cost came to 306 DH per hectare. The traditional wooden plows and harness arrangements were unsatisfactory for eradication of the sage without repeated plowings. The horses and mules were too emaciated and poorly harnessed to do an

effective job. Metal plows and suitable harness were procured for the trials but, although attempted, there was not sufficient time to train the operators and the animals in the use of the more effective equipment. Following plowing, the land was broadcast seeded to intermediate and tall wheat grasses. The results from the animal plowing and broadcast seeding are both considered unsatisfactory.

F. Natural Revegetation

In order to assess the potential capability of the sites for increased forage production through natural rehabilitation, deferred areas covering approximately 150 hectares were established in connection with the 1969-70 and 1970-71 reseeding.

The sage areas deferred since 1969 on the Plaine de Tafrata have shown little vegetative response to the exclusion of livestock indicating that total deferment would not only be uneconomic but would result in minimal increased forage production as well. As would be expected on annual grass ranges, the response to total deferment at the Ait Rbaa site has been negative. The response of the sage range on the Plaine d'Arid to total deferment, although better than Tafrata, would not warrant total deferment for a period of years as an economic means of range rehabilitation according to results to date. Although the plants in the deferred areas are more vigorous and productive than before, their inherent productive capability is far below the productive potential of the land on the upper Plaine d'Arid. Proper use and rotational systems of management can result in increased vigor of the herbage without long term deferment.

Long term deferment of rangelands is therefore not recommended for the sites used in these studies.

G. Chemical Control of Undesirable Plants

A study was initiated in April 1971 by IVS technician F. Rudolph Vigil on the chemical control of jujubier (*Ziziphus lotus*) on the Plaine de Tafrata. Jujubier is a thorny, perennial brush species of very low grazing value for cattle and sheep. It is found throughout North Africa. The limbs are used for construction of temporary fences and corrals, for firewood, etc., however, on many sites it becomes a difficult pest growing in dense stands inhibiting forage and crop production.

Traditional methods of control such as cutting, burning, and plowing are either ineffective or very expensive for the species has a tremendous capacity for regeneration. Unless the root crown, which is at a depth of about 40 cm, is severed from the roots, mechanical

control is futile. Therefore, an effective herbicide for control of jujubier could result in substantial savings annually where it is a problem.

First year results from the study have been very encouraging. Three herbicides were applied at various rates, combinations and stages of growth with a 15 liter back sprayer.

Herbicides and solutions used were as follows:

<u>Herbicides</u>	<u>Pounds of Active Ingredients per 100 gals. solution</u>
1. 2, 4, 5-T Butoxyethanol ester of 2-4-5 trichlorophenoxy- acetic acid	2, 4, 6
2. MCPA Amine form of 2, methyl- 4-chlorophenoxyacetic acid	2, 4, 6
3. Banvel 2-Methoxy-3-6 dichloro- phenoxyacetic acid	2, 4, 6

The herbicides were applied during the following stages of growth:

1. Early summer, leaves developed, plants growing rapidly.
2. Late flowering - early fruit stage.
3. Re-sprouts of brush that had been cut the year before.

Good initial results were obtained from 2,4,5-T applied at 4 lbs/100 gallons solution and 2,4,5-T or MCPA at 2 lbs plus 2 lbs of Banvel per 100 gallons of solution. The effectiveness of the treatments cannot be determined, however, until the end of the 1972 growing season. Many of the plants that now appear dead may regenerate. Further trials should be conducted.

H. Hay Production

Due to the need for reserve and supplementary forage during the winter months and in times of stress, 52 hectares of annual cereal rye (*Secale cereale*) and oats, (*Avena sativa*) in combinations with sweet clover (*Melilotus alba*) Hairy vetch (*Vicia sativa*) and Sulla (*Hedysarum coronarium*) were seeded during the fall of 1970 on the Plaine d'Arid near the wheat grass seedings. A similar planting of 52 hectares was also made on the Plaine de Tafrata.

All the seed, except for 2 hectares seeded to Elbon rye, was purchased locally from uncertified stock and unfortunately was of poor quality - especially the rye - resulting in fair to poor stands. However, the two hectares seeded to Elbon rye from seed purchased in the U.S. produced heavily at all locations. Not only did the Elbon rye establish seedlings much earlier than the local varieties of rye and oats, but far exceeded them in production.

Established stands of crested and intermediate wheat grass provided grazing as early as the annual cereals, therefore, there was no advantage from the cereals as far as early forage is concerned. A portion of the cereals on the Plaine d'Arid were grazed for a short period in May. A noticeable reduction in yield resulted because the animals began grazing later than desired.

It was planned to seed the Plaine d'Arid cereal site in October to Intermediate wheat grass following the hay crop by drilling the seed into the stubble. For comparative purposes part of the site was to be ^{be}disced and rolled before seeding, however, the seeding plans have had to be deferred. As previously mentioned it was possible, however, to seed 29 hectares of the cereal land on the Tafрата to perennials in November 1971.

The local livestock operators should be encouraged to produce hay for their animals either through the planting of cereals or cutting hay on a portion of the future seedings. This would be less costly and should be more satisfactory than constructing large central forage centers and stock-piling hay and grain in them for subsequent sale to the livestock producers.

II. INCREASING LIVESTOCK PRODUCTION

To study and demonstrate the effect of improved forage, health and management conditions on the production of local sheep a grazing and livestock production study was conducted on the Plaine d'Arid during the six month period of April 19 to October 19, 1971. Other important objectives included the study of forage production on seeded and native ranges, and a cost-benefit analysis for developing future management programs.

Four Plaine d'Arid sheep owners each provided 40 ewes with young lambs for the study. The 40 sheep provided by each cooperator were divided by lot into the following groups: 1) 20 ewes to graze with their lambs on the 40 hectares of crested wheat grass seeded in 1968 forming Flock "A" totalling 80 ewes with lambs; 2) 10 ewes to graze with their lambs on 50 hectares of native sage range (*Artemesia alba*) adjacent to the seeding and forming Flock "B" totalling 40 ewes with lambs; and 3) 10 ewes with lambs to remain

with the owner to be grazed with his other sheep under traditional management and forage conditions to form the "Control Groups" totalling 40 ewes and lambs. Each control group was further subdivided into two equal groups of five ewes with lambs, one of which was scheduled to receive the same medical treatments as Flocks "A" and "B" and designated as "Control Group A" while the other received no medication other than that normally provided by the owners or the Livestock Service for all his sheep and was designated as "Control Group B."

The ewes with the youngest lambs were selected from each owner for the study. At the time of selection only about 30 percent of the ewes in the herds had lambs. Most of the others reportedly had lost their lambs shortly after birth. Ninety-four percent of the lambs had been born during December 1970 through February 1971 and were 2-4 months or more old. Most of the lambs were stunted due to inadequate nutrition. All the animals were thin and in poor physical condition. Many suffered from internal parasites, ring worm and ticks.

In addition to the sheep, five young bulls provided by two of the cooperators grazed on the crested wheat grass with Flock "A" from May 13 through October 19. The bulls recorded a total net gain of 248.5 kgs during the six month period.

For management purposes, the seeding and the native sage tracts were each sub-divided into four fenced pastures. A simple three week, four pasture rotation grazing system was followed by each flock within its assigned tract. Water for the animals was provided in the pastures. They were placed nightly in a nearby corral with open shelter and returned to their pastures at sunrise.

At the time of selection each animal, except those in Control Group "B", was treated with Thiobenzo for internal parasite and vaccinated with Ovipan against enterotoxaemia, infectious hepatitis, blackleg, malignant edema and lamb dysentery. Due to unfavorable weather conditions and problems of getting the spraying equipment into operation, the animals were not treated for external parasites until after shearing in mid-June. Follow-up treatments for both internal and external parasites were repeated in mid-July. All the animals were weighed on a monthly basis. In addition, selected animals in Flocks "A" and "B" were weighed twice monthly.

A number of the ewes in Flock "A" came into heat in mid-June necessitating the weaning of the ram lambs on June 24, as they were attempting to breed the ewe lambs, even those that weighed around 15 kgs. The ewes in Flock "B" came in heat nearly two months later necessitating weaning of the ram lambs in that Flock on August 12. They were placed with the Flock "A" rams on the crested wheat grass

seeding where they remained until the last week of the study. The attempted breeding effected the weight gains of the ram lambs. The full extent is unknown and needs further study. Uncastrated lambs apparently will cause serious management problems for any improved management program.

On July 16 all the animals owned by the cooperator from Bou Mia were withdrawn from the study except one lamb which was left with Flock "B".

The ewe lambs in Flocks "A" and "B" were weaned on August 13. On August 19 the ewe lambs and ewes were transferred to the intermediate wheat grass seeding of 1970-71 and the aftermath of the annual cereal rye and oats which had been harvested for hay. The switch in pasture was made to obtain an indication of carrying capacity of the intermediate seeding and also to flush the ewes for breeding. They remained there until the study was terminated on October 19.

The ewes were bred during the period of mid-September through mid-October to six rams (2 Sardi, 2 Ile de France and 2 French Merino) for lambing in February and March 1972. In addition to the mature ewes, 67 percent of the ewe lambs in Flock "A" were bred compared to 30 percent of those in Flock "B".

The study was terminated on October 19 and the animals returned to their owners. Although it was necessary to conduct the study often without sufficient personnel equipment and supplies necessitating many makeshift arrangements; nevertheless, the study achieved its primary objectives.

A. Results

To facilitate comparison the statistics which follow relating to livestock production exclude the animals removed by the cooperator from Bou Mia before the completion of the study except where noted.

Table 4 - Comparison of Lamb Production
Based on Live Weight

	No. of Lambs		Avg. Weight (Kgs)			Lamb Production (Kgs)	
	Apr.19	Oct.19	Apr.19	Oct.19	Net Gain	Per Ewe	Per Hectare
Flock "A"	60	56	6.9	25.0	18.1	23.4 ^{1/}	45.7 ^{2/3/}
Flock "B"	31	31	6.9	22.9	16.0	22.9	16.0 ^{3/}
Group "A"	15	11	6.8	19.5	12.5	14.1 ^{1/}	-
Group "B"	15	12	6.4	16.5	10.1	13.2 ^{1/}	-
Avg. Groups "A" & "B"	30	23	6.6	17.8	11.2	13.7 ^{1/}	9.1(est.)

^{1/} Adjusted for death loss

^{2/} When gains of the bulls are included the meat production figure is 51.9 kgs/ha

^{3/} Includes gains of Bou Mia lambs removed on July 16

As shown in Table 4, the live weight production per hectare from the lambs alone was five times greater (45.7 kgs vs 9.1) on the wheat grass than that under traditional management and nearly three times greater than on the sage range under improved management (45.7 kgs vs 16.0). The difference between the production Flock "A" on the seeded range and Flock "B" on the sage range is due primarily to the increased carrying capacity of the seeded range which during the study was approximately three times greater. However, the difference between production recorded by the lambs in Flocks "A" and "B" and the Control groups under traditional management is due primarily to adequate nutrition vs mal-nutrition.

Lamb production per breeding ewe was approximately 60 per cent greater for Flock "B" grazing on native sage range under improved management, forage and health conditions than that recorded by the control animals grazing under traditional conditions. Had the study covered the winter months as well the difference in production would undoubtedly have been much greater due to the heavy death losses which frequently occur in traditionally managed flocks. In addition the present traditional management practice of leaving the rams throughout the year with the ewes results in heavy lamb mortality in areas like the Plaine d'Arid. Because of the uncontrolled breeding many of the lambs are now born during the winter months when conditions for survival and growth are at their very worst.

Controlling the breeding cycle could increase lamb production an estimated 30 percent or more in the cold winter areas such as Plaine d'Arid and could contribute substantially to increased production and income to the owners. Effective control of the stocking rate of the range and the breeding cycle of the ewes, both of which are functions of management, could conceivably double the present production per ewe without any costly rangeland development measures.

While the rate of gain recorded by the lambs in Flocks "A" and "B" is very good compared to that of the Control Groups, it is actually quite poor in relation to the quality of the forage they were grazed on. This is due primarily to their stunted condition at the beginning of the study and also to their inherent slow growth rate. The body weights attained by October should have been attained by July. The rates of gain and selling weights could be materially increased through improved breeding as could the lambing percentages provided good management and good forage conditions prevailed.

Table 5 - Comparison of Weights and Wool Yield of the Ewes

	No. of Ewes		Average Weight (Kgs)		Net Gain	Average Kgs Wool Production
	4/14	10/19	4/19	10/19		
Flock "A"	60	59	22.7	35.7	13.0	1.2
Flock "B"	30	29	22.9	33.8	10.9	1.3
Group "A"	15	15	22.1	29.2	7.1	1.2
Group "B"	15	14	22.1	29.3	7.2	1.3
Groups A & B	30	29	22.1	29.2	7.1	1.3

Although the ewes in Flock "A" were heavier than those in Flock "B" both were in very good condition at the conclusion of the study. In comparison, the ewes in the control groups were observed to be only in fair condition.

Due to the few animals comprising the control groups, the results should be considered only as indicators and used cautiously. The data suggests, however, that medicinal treatments such as those given to Group "A" are of little benefit to the animals from the overall production standpoint so long as they suffer from malnutrition.

B. Wool Production

Wool production was extremely low - 1.3 kgs average - for all the animals in the study. The improved forage conditions provided Flocks "A" and "B" during the two months immediately preceding shearing had no measurable effect on wool production. The average yield was essentially the same for the animals under improved management as for the control groups. However, in October, at the end of the study, a marked improvement could be observed in the condition and growth of wool, on the ewes in Flocks "A" and "B" compared to the ewes in the Control groups, indicating that the yield would be significantly higher, perhaps as much as 25 to 40 percent or more, if they were provided adequate nutrition until shearing next June.

C. Ewe and Lamb Mortality

Table 6 - Summary of Mortality From All Causes
During the Study

Flocks and Groups	Ewes		Lambs	
	No. of Deaths	Percentage*	No. of Deaths	Percentage*
Flock "A" (60 ewes, 60 lambs)	1	2	4	7
Flock "B" (30 ewes, 31 lambs)	1	3	0	0
Group "A" (15 ewes, 15 lambs)	0	0	4	3
Group "B" (15 ewes, 15 lambs)	1	7	3	2
Groups A & B (30 ewes, 30 lambs)	1	3	7	2

* Expressed to nearest whole number

Mortality among the ewes was relatively low in all the herds. No more than one ewe died in each herd. The first death occurred in Flock "B" in July and the last death on October 18 in Flock "A" - the day before the sheep were returned to the cooperators. Death in both cases was preceded by a very short illness. The exact cause was not determined by the autopsy, however, as in the cases of the lambs that died in Flocks "A and B" death was not caused by endemic or contagious diseases.

The death of two of the four lambs in Flock "A" resulted from handling during the periodic weighing operation. The lambs became over-heated as the day was hot and weighing was prolonged due to problems with the scale. Both lambs (rams) died almost simultaneously within a half hour after their return to their pasture. Of the other two Flock "A" lambs that died, one death occurred in May and the other in August. The autopsy showed degeneration of the heart and hemorrhaging.

Except for a few cases of dysentery among the ewes and lambs in Flock "B" which occurred in June and September (cured without loss), the ewes and lambs in both Flocks remained healthy requiring no special medical attention other than treatment for parasites.

Table 7 - Analysis of Death Losses in the Control Groups

Cooperators	Ewes		Lambs	
	No. of Deaths	Percentage	No. of Deaths	Percentage
<u>Cooperator One</u>				
Group "A"	0	0	0	0
Group "B"	1	20	1	20
<u>Cooperator Two</u>				
Group "A"	0	0	4	80
Group "B"	0	0	1	20
<u>Cooperator Three</u>				
Group "A"	0	0	0	0
Group "B"	0	0	1	20

Mortality among the lambs in the Control groups was higher than for Flocks "A" and "B" and varied considerably among the Cooperators as shown in Table 7. Cooperator Two, who suffered the heaviest

lamb mortality, had the poorest sheep throughout the study reflecting severe malnutrition and parasite infection. Two of his lambs in Group "A" died in April a few days following initial parasite treatment and vaccination. Their deaths may have been caused by the treatments applied, however, there were no other deaths recorded among all the animals treated that could be attributed to the treatment. The other deaths which occurred among the animals in the Control groups were spread well over the entire period of the study.

Except in the case of Cooperator Two, the results in Table 7 indicate that the health control measures applied to "Group A" were effective in reducing lamb mortality. However, due to the small number of sheep involved in each Group, the results should be considered as being only indicative at best.

III. RANGE USE AND LIVESTOCK PRODUCTION STUDIES - TRADITIONAL FLOCKS

A. Range Use and Sociological Studies

Reliable data concerning the present use of the range resources and information concerning the livestock operators, their dependence on the communal lands, their interests, capabilities and limitations are essential for the preparation of sound management and development plans. Studies to obtain such data were initiated in May 1970 for the proposed Improvement Perimeters in the Plaine d'Arid and Tafrata.

Detailed records have been established on more than 300 resident livestock operators controlling more than 41,000 sheep and goats and nearly 1700 cattle, horses, donkeys and camels on the Plaine de Tafrata. Records established for the Plaine d'Arid area involved 502 livestock operators grazing a total of 44,568 sheep plus substantial numbers of goats and other animals.

The studies indicate that the livestock operators can be classified into the following three broad groups:

Resident operators are livestock owners who live in or near the perimeters and normally graze their livestock throughout the year entirely or almost entirely within the perimeters. They may be considered legally fully dependent upon use of the perimeters.

Seasonal operators are livestock owners living in the Province who normally graze their livestock in the perimeters on a seasonal basis varying from a few weeks to six months or more and are dependent upon the forage in the perimeters for a portion of the year. They are considered to have a legal right to graze their livestock in the perimeter.

Transit operators are livestock owners who live outside the Province and graze their livestock seasonally or occasionally for

a few weeks or months (depending on forage conditions at home) in the perimeters through tribal or administrative authorization. They are not considered to have an established legal right to graze livestock in the perimeter.

In addition to the above classification, the livestock operators may be further grouped relative to the ownership of the livestock which varies from ownership by the operator-herder to ownership by farmers, merchants, public officials, etc. and grazed under a salary or share arrangement.

A substantial portion of the flocks in the communal land areas appear to be herded on a salary basis by hired shepherds often related to the owner. Substantial numbers are also grazed under "Association" arrangements which may be defined in the simplest form as an arrangement whereby a person with grazing rights grazes livestock owned by a person without rights for a fee or share. The family actually doing the herding is frequently large, lives most, if not the entire year in a tent existing on a bare subsistence income. The level of literacy is extremely low among these families. Probably less than 10 percent of the children have an opportunity to attend school.

B. Livestock Production Baseline Studies

Baseline studies of the traditional sheep flocks were initiated on the Plaine d'Arid and Tafrata in late 1970. The objective was to determine the present level of production, mortality, sales, lambing percentages, etc., and to identify major problems affecting income and production.

The flocks of ten owners varying in size from 130 to 481 ewes were ear-tagged with metal tags for the studies. Detailed records were established for each ewe including birth of lambs, death, sales and other pertinent information. Unfortunately, lack of personnel and/or funds to maintain regular contacts with the owners and their flocks required suspension of all the studies except the one on the Tafrata before significant data could be recorded. Resumption of the studies should be given priority.

IV. CONTROLLING THE USE OF THE COMMUNAL RANGELANDS

To increase forage and livestock production on the communal lands, the use of the lands for grazing and cultivation must be brought under effective control. Efforts to develop the rangelands and increase the productivity of the livestock are futile and can only result in the disappointment and the waste of the money invested unless the use of the range resources can be controlled to halt destructive overgrazing.

The single most important cause of the low level of livestock production per breeding animal is the lack of adequate forage necessary to maintain healthy productive animals during most of the year. Hunger is by far the main "disease" of livestock in Morocco.

While it is easy to prescribe in general terms the requirements for balancing forage production with livestock use, etc. to actually bring about the change on communal lands is quite a different matter. Communal lands have been used for centuries, virtually without limitation, by large numbers of livestock owners without defined ownership boundaries or rights. Most of the flocks ranging from 100 to 400 sheep, and with low production the operations are largely at bare subsistence levels. Therefore, any action which restricts or reduces livestock numbers is viewed by the livestock operators as a threat to their survival. In their opinion, they already have too few animals to meet their needs.

A successful effort in rangeland development and livestock improvement must deal with the problems of tradition, legislation, administration, availability of trained personnel and the operating costs inherent in the establishment of a meaningful program of interrelated activities.

The Livestock and Rangeland Improvement Project was originally established with the goal of bringing twelve areas covering 325,000 hectares under management in a period of three years.

Unfortunately, adequate consideration was not given to the sociological problems involved and to the complicated local conditions of land use and tenure. Proper attention was not given to informing the people in the two areas first selected for development about the project and preparing them for the development actions to follow. Also qualified Moroccan technicians were not available at the time to properly negotiate with the local livestock operators and direct the project activities. As a result in the second year of the project (1969) strong opposition developed from the local people it was designed to help because of their fear that they would not be able to continue to use the land and that the number animals they could graze would be reduced.

In recognition of the problems which had developed, the project was redirected in early 1970 to intensify the research elements and reorient implementation plans to conform to the provisions of the Agricultural Investment Code (Dahir 1-69-171) enacted in July 1969, relating to communal land development. The magnitude of the project was also reduced from twelve proposed management area covering 325,000 hectares to two areas, the Plaine d'Arid and Plaine de Tafрата covering 70,000 hectares. Provision also was made for the

establishment of a small pilot area of approximately 3,000 hectares in each perimeter for intensive research in improved livestock and range management practices. The two areas were to be established by Royal Decree under the new Code as "Range Improvement Perimeters."

The administrative and technical resources devoted to the project were to be strengthened by the establishment of a Grazing Perimeter Section within the Livestock Service with national and provincial offices headed by graduates of the National Agricultural University or other qualified officers to give overall direction to implementation of the development programs. A National Committee was established to provide policy direction and to coordinate the activities of the various Moroccan agencies having responsibilities and competence in the various disciplines relating to communal land development. Provincial Committees for the two provinces concerned were also established in accordance with the new Code to coordinate the activities at the Provincial level.

Dahir 1-69-171 of the Code established a new legal base for the management and development of the country's communal grazing lands with the stated purpose "to check the damages caused by grazing and to assure the rehabilitation of the rangelands." The law authorizes the establishment of management areas by decree designated as "Range Improvement Perimeters" and sets forth regulations governing the management and development processes and the penalties for violations.

V. RESULTS

The first drafts of the Royal Decrees to establish the Plaine d'Arid and plaine de Tafrata areas as "Grazing Improvement Perimeters" were prepared in early 1970. Following legal review and approval, they were submitted to the two Provincial Committees concerned who strongly endorsed their issuance after which they were forwarded in July 1970 to the Ministry for final processing and issuance as Royal Decrees.

Drafts of Ministerial Orders were prepared as the second formal step in the application of the Code to start the process of adjudication of grazing privileges, the issuance of permits, and the closure of the perimeters to grazing and cultivation except by permit.

An aggressive information program was carried out during 1970 in the Plaine d'Arid and Tafrata to inform the people of the objectives and requirements of the development programs being planned for their areas in connection with the range use and sociological studies. More than 100 scheduled meetings were held with local officials and livestock operators as well as numerous unscheduled gatherings to obtain their views, discuss problems and explain the main features of the proposed development programs.

Unfortunately, the issuance of the decrees and orders was suspended as the Ministry became involved in studies and reorganization plans which included reassessment of program priorities leading to the preparation of the next 5-year Economic Development Plan for the period 1973-77.

The Livestock Service is currently in the process of implementing reorganization plans. The Service as restructured is considerably enlarged. It consists of two primary Division, one of which is concerned with Animal Health and related activities, and the other with Livestock Production including the development of the range resources. In keeping with the new organizational structures, the Livestock and Rangeland Project as presently conceived can now be phased out as of June 30, 1972 and the activities assigned to the new Division of Livestock Production of the Livestock Service.

Personnel trained in the science of range management and development are essential to the success of programs for the development of the range and livestock resources. Short term and academic training is available for Moroccan technicians under the project. Currently Mr. Otman Squalli, graduate of the National Agricultural School at Meknes, is studying at New Mexico State University on a two-year advanced degree program leading to a Master's Degree in Range Management in May 1972. Advanced degree training for three additional Moroccan technicians has been included in the project.

Although it was not possible to begin the actual range administration process and test the adequacy of the Code under field conditions, valuable data and experience were gained about the economic and social problems involved and the production potentials of the land and livestock resources.

The pastoral people without question want help and the majority will support a range and livestock development program properly designed to meet their needs and increase the production of their land and livestock resources. The provincial authorities and local officials concerned also recognize the need for management programs to increase livestock production and the income of the pastoral people.

Management and development programs should be designed to include the active participation of the people concerned in the planning and implementation processes. The Agricultural Investment Code requires modification to simplify and accelerate the procedure for establishing development areas and to make development a partnership arrangement between the livestock people and the government where the resources of both are pooled for maximum development.

While the project has dealt with communal lands, the same basic problems apply in general to production on the private lands under traditional management. However, the returns from improved practices on private rangelands should be higher than on the collective lands primarily because they are usually of higher productive potential. The owner also has greater interest in investing time and money in their development. However, due to the difference in ownership status, the approach to development would be different. In the case of private rangelands, a well organized financial and technical assistance extension program should be considered. For example, financial help in the form of loans, subsidies and incentive payments could be given livestock producers who enter into range and livestock improvement programs similar to that provided by the U.S. Agriculture Stabilization and Conservation Service. On the communal lands, a strong administrative authority is needed to adjudicate the grazing rights to determine who will be allowed to graze on the lands and with how many livestock and to issue grazing and cultivation permits until other arrangements are made. Formation of the ethnic groups into cooperatives or ranching associations has merit. Loans, subsidies and incentive payments, however, have application on the collective lands as well.

VI. ECONOMIC FEASIBILITY

The economic summary which follows is designed to show the estimated costs and benefits which would accrue if 350,000 hectares of communal rangelands were brought under improved management including seeding to improved species where conditions are suitable, and range improvements such as wells, reservoirs, shelters, etc. constructed where required. The analysis, which was prepared by Mr. Norman Ulsaker, Agricultural Economist, USAID/Rabat, in collaboration with the author, is based on land and livestock conditions approximating those found on the Plaine d'Arid at Midelt. It is assumed that 30% of the land can be successfully seeded to perennial range forage species. Other assumptions are based on observations, preliminary analysis of data collected under the Livestock and Rangeland Improvement Project and best informed judgments.

Estimated Production, Costs, and Returns for Improved Practices
versus
Existing Practices on 350,000 hectares Collective Grazing Land
Similar to Plaine d'Arid Conditions

<u>Production and Returns</u>	<u>Existing Practices</u>	<u>Improved Practices</u>
Breeding Ewes	250,000	200,000
Animals remain in area	8 months	11 months
Annual Meat Production	1,951,000 kilos	3,881,800 kilos
Annual Wool Production	341,000 kilos	312,000 kilos
Total value - meat and weel	8,688,750 DH.	15,727,000 DH.
Annual variable costs		
Veterinary and health	66,250 DH.	832,000 DH.
Supplemental Feed	787,500 DH.	2,392,000 DH.
Total	853,750 DH.	3,224,000 DH.

Returns above variable costs	7,835,000 DH.	12,503,000 DH.
Returns reduced since land used less than 12 months	5,223,281 DH.	11,461,000 DH.
Added returns for improved practices		6,237,719 DH.

Capital Investment Costs

100 wells @ DH. 8500	850,000 DH.
50 dipping vats and facilities @ DH.2000	100,000 DH.
105,000 hectares reseeded (30% of 350,000) @ DH.150	15,750,000 DH.
Total	16,700,000 DH.

Annual amortized cost (15 years at 6% interest)	1,719,000 DH.
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Financial Indicators

Number of years required to pay off direct capital investment costs	2.7
Annual return on capital investment	37%
Added annual return for improved practices less amortized direct capital investment costs, total	4,518,719 DH.
Per Hectare	12.91 DH.

NOTE: The above production estimates are based on the following assumptions:

1. Lambing percentage	90%	95%
2. Death losses		
Mature Animals		
Ewes	12%	6%
Rams	6%	3%
Lambs	40%	15%

Table - Cont'd

Variable Costs

Veterinary and Health (DH 4.0/head x 208)	832 DH
Supplemental feed (DH 11.5/head x 208)	<u>2,392 DH</u>
Total variable costs	3,224 DH
Return above variable costs	12,503 DH

Improved practices includes capital costs for well, dipping vats, shelters, and reseeding amounting to approximately 48 dirhams per hectare.

The projections for increased livestock production are based upon the implementation of sound management and development programs. This process must begin with ensuring that the animals have enough forage during the year to meet nutritional requirements for a healthy productive animal. To implement such a program will require an efficient administrative organization with competent personnel supported by adequate legislation.